

# Trends in Population-Based Active Surveillance for Shigellosis and Demographic Variability in FoodNet Sites, 1996–1999

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*Shigella* is a common cause of diarrhea in the United States, and accurate surveillance is needed to determine the burden of illness that they cause. Active surveillance for culture-confirmed *Shigella* infection was done as part of the Foodborne Diseases Active Surveillance Network (FoodNet). A total of 4317 cases of shigellosis were reported during 1996–1999 in the original FoodNet surveillance areas. The average annual incidence was 7.4 cases/100,000 population. The incidence was similar during 1996–1998, but it declined in 1999 to 5.0 cases/100,000 population. State-to-state variability was seen in the incidence of shigellosis. Higher incidence was observed in California and Georgia. *Shigella sonnei* accounted for 70% of the infections, followed by *Shigella flexneri* (24%). Compared with other age groups, the incidence was highest among children aged 1–4 years (36.3 cases/100,000 population). Marked demographic differences were observed between infections with *S. sonnei* and *S. flexneri*.

*Shigella* is a common cause of diarrheal illness, and they have caused numerous foodborne outbreaks and outbreaks in day care centers [1]. Limited population-based data are available on the burden of illness caused by *Shigella* species [2]. Although there is national surveillance for culture-confirmed *Shigella* infections, milder cases may not be culture-confirmed, and some culture-confirmed cases may not be reported.

*Shigella* infection is easily transmitted from person to person by the fecal-oral routes; as few as 10–100

organisms can cause infection [1, 3]. Outbreaks of *Shigella sonnei* infection in day-care centers and in the community can last for weeks or months and are often difficult to control [4–6]. Transmission in day care centers can be reduced by the exclusion or segregation into cohorts of symptomatic or culture-positive individuals. In contrast, *Shigella flexneri* and other species of *Shigella* have not commonly been transmitted in day-care centers but have appeared in occasional foodborne outbreaks. *S. flexneri* also has been transmitted among adult men, possibly via homosexual contact [7].

The Foodborne Diseases Active Surveillance Network (FoodNet) is the principal foodborne-disease program within the Emerging Infections Program of the Centers for Disease Control and Prevention (CDC). FoodNet is a collaborative effort among the CDC, the US Department of Agriculture, the US Food and Drug Administration, and selected state health departments. The objectives of FoodNet are to estimate the frequency and severity of foodborne diseases, including shigellosis,

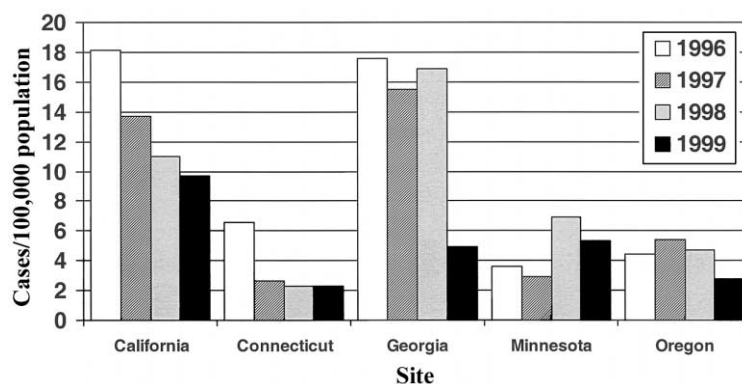
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**Figure 1.** Incidence of culture-confirmed *Shigella* infections in the original FoodNet sites, 1996–1999

that occur in the United States each year and to describe their epidemiology [8].

## SUBJECTS AND METHODS

FoodNet started in 1996 with 5 surveillance areas (also known as “FoodNet sites”) (selected counties in California, Connecticut, and Georgia and the states of Minnesota and Oregon) and expanded with the addition of New York and Maryland in 1998 and of Tennessee in 1999. Besides these additions, the surveillance area in Connecticut expanded by the addition of 1 county in 1997 and all remaining counties in the state in 1998. In addition, Georgia added 12 counties in 1997 and all remaining counties in the state in 1999. The total population under surveillance by FoodNet in 1996 was 14,281,096, or 5% of the US population. By 1999, the surveillance area had expanded to 25,859,311, or 10% of the US population. The population in the original surveillance area was 14,281,096 in 1996; 14,424,944 in 1997; 14,621,702 in 1998; and 14,782,206 in 1999. Therefore, the populations in the original and expanded surveillance areas in 1999 were 14.8 and 25.9 million persons, respectively.

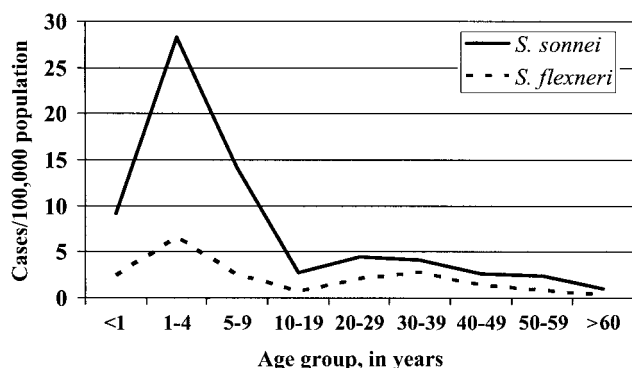
FoodNet sites conduct active surveillance for 7 bacterial pathogens (*Campylobacter*, *Salmonella*, *Shigella*, *Listeria*, *Yersinia*, and *Vibrio* species and *Escherichia coli* O157). We have regularly contacted all clinical laboratories in the FoodNet surveillance area since 1996 to comprehensively ascertain culture-confirmed cases of shigellosis. FoodNet staff collected demographic characteristics and outcome data from patients or their medical records. Data were entered into the Public Health Laboratory Information System and transmitted to the CDC routinely. Aggregate data were compiled at the CDC and sent to each site. To calculate rates, population estimates were used for the corresponding years. Analyses were done using SPSS software [9]. We conducted the present study in accordance with guidelines for human research as specified by the US Department of Health and Human Services.

We report surveillance data for 1996–1999 from the original FoodNet surveillance area, which included Minnesota, Oregon, and selected counties in California, Connecticut, and Georgia. To determine temporal trends and to avoid statistical complications introduced by comparisons of incidence across time in a variable surveillance area, only data from the original surveillance area were examined when assessing year-to-year variation. The 1999 data, which included the expanded surveillance area in 7 sites, are also presented. A comparison of the distributions of infections with the 2 most common serotypes, *S. sonnei* and *S. flexneri*, by the age, sex, race and ethnicity of case patients and by site is included. Because of the small numbers of infections caused by *Shigella boydii* and *Shigella dysenteriae*, separate analysis was not done for these serotypes.

## RESULTS

A total of 4317 culture-confirmed cases of shigellosis were identified in the original FoodNet surveillance area during 1996–1999. The incidence was 8.9 cases/100,000 population in 1996; 7.4 cases/100,000 population in 1997; 8.5 cases/100,000 population in 1998; and 5.0 cases/100,000 population in 1999, for an average incidence of 7.4 cases/100,000 population. There was substantial site-to-site variability in the incidence of shigellosis: California and Georgia had the highest rates of illness in most years (figure 1). California and Connecticut showed a steady decline in incidence during 1996–1999, whereas other sites showed fluctuations. The site with the greatest single-year change in incidence was Georgia, with a 71% decline from 1998 to 1999.

The incidence of shigellosis was highest in late summer and early fall. Thirty-six percent of cases occurred between July and September. The average annual incidence was highest among children aged 1–4 years (36.3 cases/100,000 population), male patients (7.8 cases/100,000 population), blacks (16.1 cases/100,000 population), Hispanics (16.2 cases/100,000 popula-



**Figure 2.** Incidence of culture-confirmed *Shigella sonnei* and *Shigella flexneri* infections in original FoodNet sites, by age group, 1996–1999.

tion), and Native Americans (10.0 cases/100,000 population). The overall hospitalization rate was 13% of patients.

Hospitalization rates varied by state, from 11% of patients in Minnesota to 15% in Georgia; by age group, from 31% among patients aged  $\geq 60$  years to 8% among children aged 1–4 years; and by race, from 29% among Native Americans to 13% among whites. Overall, 2 people (0.1%) died. Ninety-eight percent of the *Shigella* isolates were from stool specimens, 0.5% were from blood, and the rest were from wounds, the female genital tract, and other/unknown body sites (1.5%).

There was marked demographic variability across the FoodNet sites. The incidence was highest in children aged 1–4 years in all sites. The highest rate among men in California was observed among those aged 30–39 years (25.3 cases/100,000 population). The incidence among men and women was similar in all sites except California, where the incidence among men was much higher than that of women (16.0 vs. 10.1 cases/100,000 population).

*S. sonnei* accounted for 70% of reported infections, followed by *S. flexneri* (24%), *S. boydii* (1.6%), and *S. dysenteriae* (0.8%). The incidence of *S. sonnei* infection was relatively constant during 1996–1998, and then decreased during 1998–1999. This was accounted for by the sharp decline in incidence of *S. sonnei* infections between 1998 and 1999 in Georgia, where it decreased from 13.9 to 2.3 cases/100,000 population. In California, the incidence of *S. sonnei* infections decreased from 11.5 cases/100,000 population in 1996 to 6.7 cases/100,000 population in 1999. The incidence of *S. flexneri* infections decreased slightly from 2 cases/100,000 population in 1996 to 1.5 cases/100,000 population in 1999.

**Differences between incidences of *S. sonnei* and *S. flexneri* infection.** There were marked differences in the incidences of infections with *S. sonnei* and *S. flexneri* by age and sex. The incidence of both infections were higher in the 1–4-year age group, compared with other age groups. The rate of *S. flexneri* infection had a second peak in the 30–39-year age group (figure

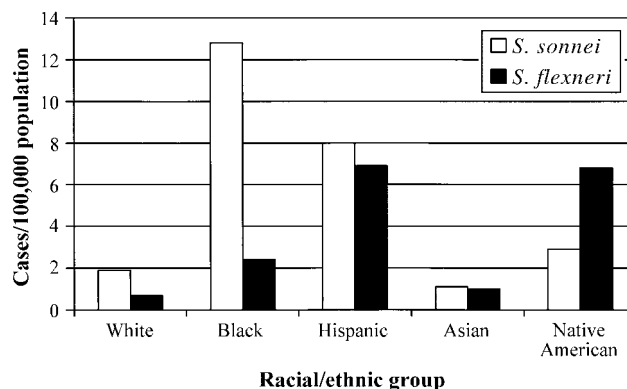
2). The incidence of *S. sonnei* among men and women was similar (5.0 and 5.3 cases/100,000 population), but the incidence of *S. flexneri* infection among men was almost twice that among women (2.3 vs. 1.2 cases/100,000 population). The 2 types of infection showed different patterns of distribution among the different racial and ethnic groups. In all of the racial and ethnic groups except Native Americans, the incidence of *S. sonnei* infection was higher than that of *S. flexneri* infection (figure 3). The incidence of infection due to *S. sonnei* was higher among blacks and whites, compared with the other groups (5.2 cases/100,000 population for blacks, 2.7 for whites, 1.2 for Hispanics, and 1.2 for Asians). All sites had a higher incidence of *S. sonnei* infection than of *S. flexneri* infection (figure 4). The ratio of the incidences of *S. sonnei* infection to *S. flexneri* infection were higher in Connecticut (4.5:1), Georgia (6.4:1), and Minnesota (4.0:1) than in California (1.5:1) and Oregon (1.3:1). The hospitalization rate varied by serotype; 20% of those with *S. flexneri* and 10% of those with *S. sonnei* infections were hospitalized.

#### Comparison of expanded and original surveillance areas.

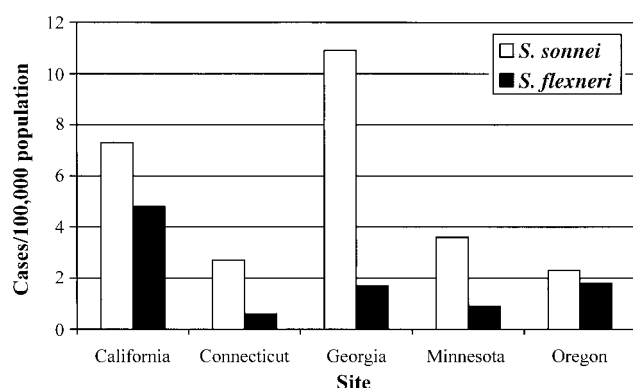
A total of 966 culture-confirmed cases of shigellosis (3.7 cases/100,000 population) were ascertained in the expanded FoodNet surveillance area during 1999, of which 737 were ascertained in the original surveillance area (table 1). In general, the incidence by the sex, age group, and race/ethnicity of case patients and by *Shigella* species was similar in the original and in the expanded surveillance areas.

## DISCUSSION

FoodNet data during 1996–1999 showed demographic differences and state-to-state variations in the incidence of culture-confirmed shigellosis. The incidence of *Shigella* infection was higher among blacks, Hispanics, and Asians than among whites. The incidence of *S. sonnei* infection was particularly high among blacks, whereas the incidence of *S. flexneri* infection was



**Figure 3.** Incidence of culture-confirmed *Shigella sonnei* and *Shigella flexneri* infections in original FoodNet sites, by race/ethnicity, 1996–1999.



**Figure 4.** Incidence of culture-confirmed *Shigella sonnei* and *Shigella flexneri* infections in original FoodNet sites, 1996–1999.

not markedly higher among blacks than among whites. The incidence of both *S. sonnei* and *S. flexneri* infections was markedly higher among Hispanics and Asians than among whites, although no other group had an incidence of *S. sonnei* infections as high as did blacks. Reasons for the differences in incidence between the racial/ethnic groups are not known. The incidence of *Shigella* infection, particularly *S. sonnei* infection, was higher in children aged 1–4 years. This is likely because of transmission of *S. sonnei* among young children in day care centers and preschools. Other studies and national *Shigella* surveillance have shown that the incidence of shigellosis is higher among children, especially those aged 1–4 years [2, 10]. The low infectious dose of *Shigella* makes it easily transmissible in day care centers, which may lack adequate facilities or supervision for proper hand washing, and among children who may not be toilet trained. Outbreaks of *S. sonnei* infection are commonly reported in day care centers [5, 11–14]. A study by Mohle-Boetani et al. [5] showed that an outbreak caused by *S. sonnei* in several day-care centers lingered for many weeks before it abated. The rapid diagnosis and treatment of ill children and the promotion of hand washing were effective measures in controlling the outbreak.

Marked regional differences were also noted in the incidence of *S. flexneri* infection, with the highest incidence in California. This regional variation was partially due to the high rate of *S. flexneri* among men aged 20–49 years. An evaluation of the high rate of *Shigella* infection, particularly *S. flexneri* infection, in the California FoodNet site found that the incidence to be much higher among men who have sex with men and people infected with HIV (442.0 cases/100,000 population), compared with the incidence among heterosexual and HIV-negative persons (12.4 cases/100,000 population) [15]. Furthermore, a case-control study by Vugia et al. [16] of adult men in San Francisco implicated sexual practices as a risk factor for *Shigella* infection, including *S. sonnei* infection. *S. flexneri* infection was associated with men having sex with men, HIV infection, AIDS, and sexual

activities involving direct and indirect oral-anal contact. Similarly, during the 1980s, Tauxe et al. [7] described an increase in the incidence of *S. flexneri* infection in national surveillance data.

California and Georgia had higher incidences of *Shigella* infection than did other sites; further study needs to be done to explain these differences. The 4-year trend analysis showed that the incidence of *Shigella* infection declined in 1999, compared with previous years; this decline was largely due to a marked decline in *S. sonnei* infection in Georgia. The reason for the decline in Georgia is not known but may be related to school-based hygienic interventions by public health officials and an exhaustion of susceptible individuals.

Year-to-year fluctuations in the number of reported cases of *Shigella* infection are common in national surveillance data. Lee et al. [17] described large increases in the number of *Shigella* cases during 1969–1976 and 1986–1988. These increases were due to increases in the number of *S. sonnei* isolates and suggested that waves of infection sweep through the population at intervals. As did FoodNet data, national surveillance data

**Table 1.** Incidence of culture-confirmed *Shigella* infections in 1999 in the original FoodNet sites (population, 14.8 million) and expanded FoodNet sites (population, 25.9 million)

Variable	Incidence, cases/100,000 population, by FoodNet site group	
	Original	Expanded
All case patients	5.0	3.7
Sex of case patients		
Male	5.4	3.9
Female	4.6	3.6
Age of case patients, years		
<1	8.5	7.0
1–4	25.9	18.7
5–9	11.9	8.6
10–19	2.5	1.7
20–29	4.7	3.9
30–39	4.4	3.3
40–49	3.0	2.2
50–59	2.2	1.6
≥60	1.5	1.3
Race/ethnicity of case patients		
White	1.9	1.6
Black	7.0	4.1
Hispanic	13.3	11.2
Asian	3.0	2.5
Native American	3.6	2.9
Infecting <i>Shigella</i> species		
<i>S. sonnei</i>	3.1	2.3
<i>S. flexneri</i>	1.5	1.0

showed a higher incidence of *Shigella* infection in the West and the South. Some of the year-to-year variability in the incidence of shigellosis in the FoodNet data is due to foodborne outbreaks. For example, in 1998, there was an outbreak of *S. sonnei* in several states in the United States and Canada that was associated with the consumption of parsley [18]. Active surveillance should continue to study the long-term trends of shigellosis.

The present review of FoodNet data during 1996–1999 demonstrates the need to conduct additional studies to understand some of the important variations in the incidence of infection by *Shigella* species. In the meantime, the accurate and timely identification of cases, followed by appropriate follow-up, is needed to prevent the transmission of shigellosis in the community. To break the cycle of transmission, educational efforts should include topics such as appropriate hand washing and safe sexual practices.

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